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Research Document 2003/098 | **Document de recherche 2003/098**

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Assessment of the 2002/2003 snow crab (*Chionoecetes opilio*) fishery off southwest Nova Scotia (NAFO Division 4X)

Évaluation du crabe des neiges (*Chionoecetes opilio*) de 2002-2003 au large du sud-ouest de la Nouvelle-Écosse (Division 4X de l'OPANO)

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ISSN 1480-4883
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ABSTRACT

Seven permanent licences and two temporary permits were issued for the 2002-03 snow crab season. The fishery was open between 1 November 2002 and 1 June 2003 with a total allocation of 600 tonnes (t). The total landings of 221 t represented a 41% decrease compared to 2001-02. The average catch-per-unit-effort (CPUE) was 8.4 kilogram per trap haul (kg/th) in 2002-03, a 44% decrease compared to 2001-02 and the lowest average CPUE recorded since the 1997-98 season. The total effort of 26,363 trap hauls was at the highest level since this fishery started in 1994. At-sea sampling in 2002-03 was limited and occurred only in the month of March. The At-sea sampling did not represent the fishery considering that over 65% of the landings had occurred before the sampling started.

The referees during the Regional Assessment Process in February 2003 recommended new ways of assessing the fishery-related data and describing how the fishery changed over time. The areal and abundance indices introduced in this stock assessment are simple, but seem to accurately reflect the historical and current state of the Southwest Nova Scotia (SWNS) fishery. Increases in landings from 1996-97 to 2001-02 (from 4 to 376 t) appear to be the result of expanded fishing grounds, increased fishing effort, and an overall increase in biomass. Commercial biomass declined in 2002-03, and that trend may continue in 2003-04.

There is limited information currently available to properly assess the stock status of snow crab in Area 4X, but current status indicators are mostly negative, which suggest a catch reduction. Being near the southern limit of snow crab distribution and located in what is considered marginal environmental conditions, the long-term stability of this fishery is doubtful.

RÉSUMÉ

Sept licences permanentes et deux permis temporaires ont été émis pour la saison de pêche au crabe des neiges de 2002-03. La pêcherie s'est déroulée entre le 1^{ier} novembre 2002 et le 1 ^{ier} juin 2003 avec une allocation totale de 600 tonnes (t). Les débarquements totaux de 221 t représentaient une diminution de 41% comparés à 2001-02. La prise-par-unité-d'effort (PUE) moyenne était de 8.4 kilogramme par casier levé (kg/cl) en 2002-03, une diminution de 44% comparé à 2001-02 et représentant la plus basse PUE moyenne depuis la saison de 1997-98. L'effort total de 26,363 casiers levés était à son plus haut niveau depuis que cette pêcherie a commençée en 1994. L'échantillonnage en mer en 2002-03 était limité et fut seulement réalisé durant le mois de mars. L'échantillonnage en mer n'était pas représentatif de la pêcherie puisque 65% des débarquements avaient déjà été accomplis avant que l'échantillonnage ne commence.

Durant le Processus d'Évaluation Régional (PER) de Février 2003, les arbitres ont recommandés de nouvelles méthodes pour évaluer les données reliées à la pêcherie et pour décrire les changements que cette pêcherie a vu depuis son commencement. Les indices de surperficie et d'abondance introduitent dans cette évaluation de stock sont simples, mais semblent quand même refléter avec exactitude l'historique et le présent état de la pêcherie du sud-ouest de la Nouvelle-Écosse (SNÉ). L'augmentation des débarquement de 1996-97 à 2001-02 (de 4 à 376 t) semble être le résultat d'un territoire de pêche accru, d'une augmentation de l'effort de pêche, et une augmentation générale de la biomasse. La biomasse commerciale a déclinée in 2002-03, et cette tendance devrait continuer en 2003-04.

Il y a peu d'information de disponible pour évaluer proprement l'état du stock de crabe des neiges de la zone 4X, mais les indicateurs présentement utilisés sont surtout négatifs ce qui suggère une réduction des prises. Comme le sud-ouest de la Nouvelle-Écosse se trouve près de la limite sud de l'aire de distribution du crabe des neiges et que les conditions environnementales y sont jugées marginales, la stabilité à long terme de la pêche est douteuse.

INTRODUCTION

Harvesting of snow crab, *Chionoecetes opilio*, in NAFO Division 4X (Area 4X; Fig. 1), off the coast of Southwest Nova Scotia (SWNS) began in 1994 (Biron et al. 2000). This fishery was managed as an exploratory fishery from 1994 to 2000. Two temporary permits were issued to native bands in the fall of 1999. In the fall of 2000, the four exploratory permits in existence since 1994 were converted into permanent licences and the first official fishing season was set for 1 November 2000 to 1 June 2001. The SWNS snow crab industry felt that better quality crab was caught during the colder months of the year. In 2001-02, two permanent licences were issued to native bands, while two exploratory licences were issued to conduct a trap survey along the near shore area of SWNS and between the two known fishing grounds, therefore bringing the total to six permanent and two temporary licences.

Only two commercial fishing grounds have been identified in Area 4X: the Roseway Basin area and the region north of LaHave Basin (Biron et al. 2000, 2003a). Following an initial period with low catch (1994 to 1997), a high concentration of snow crab was found along the NAFO fishing boundary 4W/4X in 1998 and most of the fishing effort shifted from the Roseway Basin area to the LaHave fishing grounds. Landings have been increasing steadily since 1997-98, and the 2001-02 season saw the highest landings (376 t) since the beginning of this fishery while the commercial fishing effort was directed exclusively towards the LaHave area (Biron et al. 2003a).

This fishery falls under the directives of the developing species policy in use in SWNS since 1998 and follows similar management measures as those of Eastern Nova Scotia (ENS) snow crab fisheries such as no females retained, snow crab male size greater than 95 mm carapace width (CW), no by-catch allowed, mandatory logbook, 100% dockside monitoring, and at-sea observer coverage.

Fishing season of 2002-03 – One permanent licence was issued to a native band in 2002-03, therefore bringing the total participants to 7 permanent licences and 2 temporary permits in SWNS. Permanent fishermen were allocated 75 t each and temporaries received 37.5 t each for a total allocation of 600 t. Management measures were the same as in 2001-02. Fishermen were allowed either a trap limit of 60 large traps (conical, 6 feet diameter) or 145 Japanese traps (conical, 4 feet diameter) and 30 large traps.

MATERIALS AND METHODS

Landings, catch rate and effort

Commercial catch rates – Raw data on catches and fishing effort were obtained from the mandatory logbooks that were also used for dockside monitoring. Copies of the original completed logs and the compiled electronic database were obtained from the Statistics Division of the Maritimes Region of the Department of Fisheries and Oceans (DFO). Thereafter, total seasonal landings were obtained from a revised preliminary report produced by the Statistics Division in late December 2002. The average catch-per-unit-

effort (CPUE) of the fleet at year (i) corresponds to the ratio of the total catches from the fishermen's logbooks (y_i) and the corresponding number of trap hauls (th_i) reported. Only properly completed logs were used for CPUE analysis: $CPUE_i = \sum y_i / \sum th_i$. Total effort (i.e. total number of traps hauls: TH) was estimated from total seasonal landings in the revised preliminary report produced by the Statistics Division (Y_i) divided by average CPUE: $TH_i = Y_i / CPUE_i$.

Sea sampling

Sea sampling was carried out onboard commercial vessels by certified observers to provide an assessment of the percentage of soft-shelled crabs in the catches and the size structure of crabs caught. The total number of male crabs, the position, and the depth of the trap were recorded for each randomly-sampled trap, and a sub-sample of 40 crabs was taken randomly for the following measurements: CW and chela height (ChH) using a modified vernier calliper (Watson and Wells 1970), carapace hardness (CH) of the right claw using a hardness gauge (Foyle et al. 1989) and carapace condition (CC) (Appendix I; Moriyasu et al. 1998).

Catch composition (% of different categories of crab) was estimated based on CH (hard or soft), size (legal and sub-legal) and morphometric maturity. New-soft (stage I) and clean crab (stage 2) with durometer readings <68 was considered as a postmolt soft-shelled crab (Moriyasu et al. 1998). The terminology of male maturity phase follows Sainte-Marie et al. (1995). Adult (terminal molt) and adolescent (non-terminal molt) individuals were identified based on the following discriminant function assigning individuals to the correct groups in 99% of cases (for adult males: $Y > 0$), calculated for ENS male snow crab (Biron et al. 1999):

$$Y = 19.775707 \ln (ChH) - 25.324040 \ln (CW) + 56.649941$$

Spatial analysis of the seasonal landings (areal index)

At the Regional Assessment Process (RAP) in February 2003, it was recommended to assess the fishery-related data based on a detailed description of how the fishery changed over time. At that time, it was suggested that one way to achieve this would be through a spatial analysis of the reported landings. This gives a simple areal index of the size of the commercial fishing grounds (i.e. number of 10' X 10' grids necessary to account for 95% of the catch in a given fishing season). This approach has been used in the past for northern shrimp and cod assessments in Newfoundland, Canada (David Orr, pers. comm., DFO, St. John's, NL). In general, within the Newfoundland region, CPUE was negatively related to the areal index for the snow crab stock (David Orr, pers. comm., DFO, St. John's, NL). This relationship should have been anticipated because fishermen tended to concentrate on pockets of snow crab, but when the catch rates dropped, the areal index increased as the fishermen started to search for areas with higher concentrations of crabs. Logbooks with bad locations (i.e. location on land, outside the Scotian Shelf, or outside of Area 4X) were ignored and represented 0% to 11% of the logbooks between 1995-2003.

The spatial analysis was completed as follows:

1) create a 10' X 10' grid pattern over the fishing area,
2) add up the amount of catch within each grid,
3) order the grids by increasing catch,
4) count the number of grids necessary to account for 95% of the catch,
5) repeat this process for each year throughout the history of the fishery.

Commercial snow crab availability (abundance index)

The fishing grounds have expanded substantially over the history of this fishery, especially following the increased fishing activity in the LaHave area after 1997 (Biron et al. 2000). However, the increases in landings observed during this period seem too large to be explained by expanded fishing grounds alone. While increased fishing efficiency occurred, it is not easily quantified (Biron et al. 2002, 2003a) and could only partially justify the increases. Average seasonal landings per grid of commercial fishing grounds (i.e. total seasonal landings divided by the areal index value of that given season) seems to provide an accurate index to compare the variation in abundance of the commercial-sized snow crab over the size of the commercial fishing grounds of any given season. This approach follows previous analyses where total landings were divided by km^2 of fishing grounds for any given year (Tremblay et al. 1994), however in this report, the size of the fishing grounds is expressed as 10' by 10' grids (i.e. not converted into km^2) and only grounds with commercial concentration are being considered (i.e. grids necessary to account for 95% of the catch). Therefore, by considering the seasonal variation in the size of the commercial fishing grounds to describe the availability of the commercial-sized crab in Area 4X, a relative abundance can now be compared between fishing seasons.

RESULTS

Logbooks – Reported fishing locations showed that fishing effort was distributed from the NAFO 4W/4X line in the LaHave area to the Roseway area, by following mostly the 100 m depth contour along the SWNS coast (Fig. 2). The total landings of 221 t represented 37% of the total allocation of 600 t, and a 41% decrease compared to the 376 t landed in 2001-02 with an allocation of 520 t (Table 1, Fig. 3). No participants landed their respective allocation. As for 2001-02, landings occurred early with 50% of the crab landed within the first 2 months (Table 2). The average CPUE derived directly from the logbooks (i.e. non adjusted) was 8.4 kg/th in 2002-03, a 44% decrease compared to 2001-02 and the lowest average CPUE recorded since the season of 1997-98 (Table 1, Fig. 4). The total seasonal effort of 26,363 th in 2002-03 represented a 5% increase in total effort compared to 2001-02 (Table 1, Fig. 4).

At-sea sampling by observers – At-sea sampling for the 2002-03 commercial fishery consisted of 4 trips with 69 traps sampled for a total of 732 male snow crab measured (Table 3). All four trips were sampled in March 2003 and covered both the LaHave and Roseway fishing grounds. The locations of all traps sampled by the at-sea observer program in 2002-03 are shown in Figure 5.

The catch composition showed that 89% of the measured crabs were commercial-sized adult males compared to 60% in 2001-02. Adolescent males accounted for 11% of the catch and little soft-shell crab was captured (0.8%) (Table 3). The proportion of pigmy males (adult male < 95 mm CW) was 35% in 2002-03 compared to 24% in 2001-02. The mean CW was 100 mm CW (Fig. 6), similar to the 101 mm CW reported in 2001-02. The composition of at-sea catches by CC categories showed that 80% of the sampled crab were of carapace stage 3 (Fig. 7).

Spatial analysis of the landings – Activity gradually shifted from the Roseway Basin area in 1995-96 and 1996-97 to the Lahave fishing grounds in 2001-02 (Fig. 8). The areal index can be separated into three periods: 1) 1995-2000 where the areal index increased as the landings increased; 2000-02 where the areal index remained constant as the landings increased; and 2002-03 where the areal index increased as the landings decreased (Table 1).

Commercial snow crab availability – Based on this index of abundance, the availability of commercial-sized snow crab was low between 1994-95 and 1996-97, increased steadily between 1997-98 and 2001-02, and dropped three-fold in 2002-03 (Table 1, Fig. 9).

DISCUSSION

The fishery

Logbook – None of the fishermen landed their total allocation. Overall in 2002-03, landings (221 t) decreased by 41% compared to the historical high (376 t) recorded in 2001-02, the average CPUE (8.4 kg/trap haul) decreased by 44% compared to the historical high (15 kg/trap haul) recorded in 2001-02 and is at its lowest level since 1997-98 when the use of the more efficient large traps was inexistent, and the total effort (26,400 trap hauls) was at its highest level since this fishery started in 1994. Although the average CPUE is not a reliable relative index of abundance because CPUEs are affected by factors such as soak time and a change of gear toward bigger traps (Biron et al. 2003a), such a marked decrease must be considered as a negative indicator for this fishery. According to some of the fishermen, landings and CPUE may also have been affected by bad weather in 2002-03 with strong wind making the traps less effective compared to 2001-02.

At-sea Observers – As for 2001-02, at-sea sampling in 2002-03 was limited and not representative of the fishery having occurred only in the month of March. The period with the bulk of the landings (November to February) was not covered by the at-sea sampling, while the coverage was greatly reduced and distributed over both fishing grounds, effectively creating more uncertainty considering the small sample size.

The decrease observed in the catch composition from 15% adolescent in 2001-02 to 10% in 2002-03 could be an indication that future recruitment has decreased, or may simply reflect the fact that both fishing grounds were sampled this season compared to only LaHave in

2001-02. Not knowing what was present at the beginning of the season makes the interpretation of this information very speculative.

The majority of adult male snow crabs sampled during the commercial fishery and the trap survey were of CC 3 with few older carapace stages. This may imply a high rate of removal of commercial-sized adults by the fishery.

There is limited information currently available to properly assess the stock status of snow crab in Area 4X. The overall picture indicated by the trawl survey was that this stock was very small, and under the current situation we did not see the need to continue the trawl survey in SWNS (Biron et al. 2003a). Therefore, the management of this fishery must primarily rely on fishery-related data. In this context, at-sea observer data are a very important source of information that describes the composition of the catch by categories such as CC, CH, CW, and maturity.

Spatial analysis – Distribution of the landings by 10' x 10' grids showed the trend of the 4X fishery. Following the initial period of exploration of 1994-95, the fishery concentrated in the only area known to harbour commercial concentration between 1995-97: the Roseway Basin. Landings, the areal index and the abundance index were at their lowest during that period. In 1998, a concentration of crab was found along the NAFO fishing boundary 4W/4X that resulted in the relocation of the fishing effort to that area (Biron et al. 2000). During the period of 1997-2002, the areal index and abundance index seemingly increased in accordance to the increasing landings. This has to be anticipated because this period simply reflects the increase in snow crab availability, expanded commercial fishing grounds, and favourable habitat observed after 1997. The marked decrease in the total landings and abundance index also expressed by a marked increase in the areal index, suggest a decline in the available commercial biomass in the season of 2002-03.

Snow crab abundance

Large increase in landings from 1996-97 to 2001-02 (from 4 t to 376 t) appear to be the results of expanded fishing grounds, an increase in total effort, and an increase in biomass. Increased abundance and biomass of commercial-sized snow crab over that period is indicated by increased CPUE and higher abundance index. There are various possible explanations for changes in abundance of snow crab in SWNS. Compared to other snow crab fishing areas on the Scotian Shelf, the waters on LaHave and Roseway fishing grounds tend to be warmer, and usually reflect the presence of Warm Slope Waters that penetrate the shelf through the channels and gullies (DFO 2003, Drinkwater et al. 2003). At times, however, cold (4°C-8°C) Labrador Slope Water flows into the region from the north and replaces the Warm Slope Water. Such an event occurred in 1998 and persisted for approximately 1 year (DFO 2003, Drinkwater et al. 2003). That year, the central and southwestern Scotian Shelf experienced the coldest near-bottom temperatures in the then 29-year record of groundfish surveys (DFO 2003). There is little doubt that a more favourable habitat for the snow crab was available on the southwestern Scotian shelf. The increase in habitat is indicated by the increase in the areas being fished observed after

1998. Crabs were absent from those same areas during the initial exploration phase of 1994-1996 (Biron et al. 2000).

There is also little doubt that immigration of crabs from Crab Fishing Area (CFA) 24 has contributed to the increase in snow crab abundance in 4X, especially after 1998 in the LaHave area, but it is not easily quantifiable. However, based on tagging studies carried in ENS since 1996, evidence of an east – west migration along the coast of mainland Nova Scotia in CFA-24 was observed (Biron et al. 2003b). Furthermore, major increases in the abundance of snow crab had been observed in ENS in the 1990s, especially in the southern region of ENS (Tremblay et al. 1994, Tremblay 1997, Biron et al. 2003b). These observations tend to justify the scenario of an immigration of crabs from CFA-24 that explain the increases in abundance in 4X.

There are indications that commercial biomass declined in 2002-03, and that trend may continue in 2003-04. After having increased for the last six consecutive seasons, the abundance index in 2002-03 decreased three-fold to level similar to 1999-00. Other indications such as the decline in total seasonal landings, the decrease in CPUE, the increasing fishing effort, and the increasing areal index also suggest that harvestable biomass decreased in 2002-03. By late 1999 or early 2000, the near-bottom temperatures in the central and southwestern Scotian Shelf had returned to above average levels (DFO 2003, Drinkwater et al. 2003). Furthermore, landings in the southern portion of ENS have increased six-fold (8,767 t in 2002) and fishing effort four-fold (102,900 th in 2001) since 1998 (Biron et al. 2003b). This increase in fishing activity in the southern portion of ENS and the expanded fishery into management sub-areas 24C and 24E along the coast of mainland Nova Scotia may directly impact on any immigration/emigration pattern that might have been beneficial to 4X in previous years. Furthermore, low recruitment observed during the trawl survey in August 2002 (Biron et al. 2003a) and limited availability of snow crab ground reported during the trap surveys in 1999 (Biron et al. 2000) and 2002 (Biron et al. 2003a) combined to the low percentage of adolescent found in the commercial catch at the end of the 2002-03 fishing season suggest that recruitment should be low in 2003-04.

The areal and abundance indices are simple, but seem to accurately reflect the historical and current state of the SWNS fishery. Areal and abundance indices are valuable stock indicators for the current state of the fishery and are complementary to other fishery information (total landings, catch rates, fishing effort and fishing locations, as well as catch composition). However, they are good indicators to forecast the state of the fishery for the following fishing season. In fact, the downturn trend in the harvestable biomass in 2002-03 could not have been predicted based on all fishery-related indicators observed in 2001-02.

OUTLOOK

Current status indicators are mostly negative and suggest a catch reduction for SWNS 4X area. A reduction of the total allocation by 50% to 70% should be considered based on the fishery indicators : total allocation ratio achieved during the 2002-03 season (221:600 t), the total average landing of the last three seasons (270 t), the increase if the number of grids from the areal index and the low prognostic for recruitment in the immediate future. However, this measure should not change the downward trend observed in the harvestable biomass, unless an unexpected pulse of commercial sized animals appears in this fishery. A prudent approach of reducing the total allocation to a level similar to the 1999-00 fishery is recommended until clear signs of stock recovery are detected (e.g. increase of CPUE and abundance index of pre-recruits in the fishery).

The snow crab stock abundance in SWNS has been described as sporadic (DFO 2002; Biron et al. 2000), ephemeral (Tremblay 1997), limited to cold pockets (Tremblay et al. 1994), located at the most southerly range of distribution for this species (Squires 1990) with marginal environmental condition (DFO 2003), therefore resulting in a fishery being more susceptible to sudden environmental changes (Biron et al. 2000). The trawl survey in 2002 confirmed that this stock was very small (Biron et al. 2003a). Presently, the long-term stability of this fishery is doubtful and accepted management practices applied in other management areas may not be applicable to this stock if the environmental conditions are not favourable. Arguably, one could be tempted to simply fish it out as there is no guarantee for a long-term snow crab population in that area. However, this downward trend should not be an opportunity to abandon all good husbandry and management measures. It is uncertain when a cold water event such as the one observed in 1998 or an increase in the Nova Scotia current might occur again, and perhaps minimum local production of larvae might be primordial in such events. Both trap surveys in 1999 and 2002, as well as the trawl survey in 2002 have reported snow crab captured in water warmer than the preferred range of 0°C – 3°C for this species (Biron et al. 2000, 2003a). This is a possibility that snow crab in area 4X have developed a certain tolerance for warmer water (4°C – 7°C), and perhaps such a characteristic would be lost if the local population is fished out.

RECOMMENDATIONS

1. There is no reason why this fishery should be any different than any other snow crab fishery in Atlantic Canada, and at-sea observer coverage should be, as in ENS, proportional to the progression of the landings with a minimum 10% coverage.

2. A prudent approach is recommended by reducing total allocation to level similar to the 1999-00 fishery, until clear signs of recovery are detected (e.g. increase in CPUE and abundance index of pre-recruits in the fishery).

3. Following the trawl survey in 2002, and under the current situation of low snow crab availability, it was decided not to continue the trawl survey in SWNS (Biron et al.

2003a). However, a trawl survey should be repeated in the future if sign of a recovery appear in this fishery.

REFERENCES

Biron, M., M. Moriyasu, E.Wade, P. DeGrâce, R. Campbell and M. Hébert. 1999. Assessment of the 1998 snow crab (*Chionoecetes opilio*) fisheries off eastern Nova Scotia (Areas 20 to 24 (and 4X)), Canada. DFO Can. Sci. Adv. Sec. Res. Doc. 1999/12.

Biron, M., L. Savoie, K. Drinkwater and M. Moriyasu. 2002. Assessment of the 1999/2000 and 2000/2001 snow crab (*Chionoecetes opilio*) fishery off southwestern Nova Scotia (NAFO Division 4X). DFO Can. Sci. Adv. Sec. Res. Doc. 2002/012.

Biron, M., C. Sabean L. Savoie, and M. Moriyasu. 2003a. Assessment of the 2001/2002 snow crab (*Chionoecetes opilio*) fishery off southwest Nova Scotia (NAFO Division 4X). DFO Can. Sci. Adv. Sec. Res. Doc. 2003/013.

Biron, M., L. Savoie, C. Sabean, E. Wade and M. Moriyasu. 2003b. Assessment of the 2002 snow crab (*Chionoecetes opilio)* fisheries off eastern Nova Scotia (Areas 20 to 24). DFO Can. Sci. Adv. Sec. Res. Doc. 2003/012.

Biron, M., E. Wade, M. Moriyasu, P. DeGrâce, R. Campbell and M. Hébert. 2000. Assessment of the 1999 snow crab (*Chionoecetes opilio)* fisheries off eastern Nova Scotia (Areas 20 to 24, (and 4X)), Canada. DFO Can. Sci. Adv. Sec. Res. Doc. 2000/17.

DFO, 2002. Southwestern Nova Scotia Snow Crab. DFO Science Stock Status Report C3-65 (2002).

DFO, 2003. Southwestern Nova Scotia Snow Crab. DFO Science Stock Status Report 2003/030.

Drinkwater, K.F., R.G. Pettipas and W.M. Petrie. 2003. Temperature conditions on the southern Gulf of St. Lawrence during 2002 relevant to snow crab. DFO Can. Sci. Adv. Sec. Res. Doc. 2003/014.

Foyle, T.P., G.V. Hurley and D.M. Taylor. 1989. Field testing shell hardness gauges for the snow crab fishery. Can. Ind. Rep. Fish. Aquat. Sci. 193.

Moriyasu, M., E. Wade, A. Sinclair and Y. Chiasson. 1998. Snow crab, *Chionoecetes opilio*, stock assessment in the southwestern Gulf of St. Lawrence by bottom trawl survey. *In* Proceedings of the North Pacific Symposium on Invertebrate Stock Assessment and Management. G.S. Jamieson and A. Campbell (eds.). Can. Spec. Publ. Fish. Aquat. Sci. 125: 29-40.

Sainte-Marie, B., S. Raymond and J.-C. Brêthes. 1995. Growth and maturation of the benthic stages of male snow crab, *Chionoecetes opilio* (Brachyura: Majidae). Can. J. Fish. Aquat. Sci. 52: 903-924.

Squires, H.J. 1990. Decapod Crustacea of the Atlantic Coast of Canada. Can. Bull. Fish. Aquat. Sci. 221: 532p.

Tremblay, M.J. 1997. Snow crab (*Chionoecetes opilio*) Distribution limits and abundance trends on the Scotian Shelf. J. Northw. Atl. Fish. Sci. 21:7-22.

Tremblay, M.J., M.D. Eagles and R.W. Elner. 1994. Catch, effort and population structure in the snow crab fishery off eastern Cape Breton, 1978-1993: a retrospective. Can. Tech. Rep. Fish. Aqua. Sci. 2021.

Watson, J. and P.G. Wells. 1970. A gauge for carapace measurements of crabs. J. Fish. Res. Board Can. 27: 1158-1161.

Table 1. Seasonal landings, catch rate, and effort statistics for Snow Crab (*Chionoecetes opilio*) for southwestern Nova Scotia (Exploratory NAFO 4X), 1994-2003.

	Licences	Total* landing Statistics (t)	Total mean CPUE (kg/trap haul)	Total Effort (trap haul)	Areal index (# grids)	Abundance index (t/grid)
1994/1995	4	17	1.8	9,406	-	-
1995/1996	4	11	1.0	11,146	3	3.7
1996/1997	4	4	1.0	3,475	2	2.0
1997/1998	4	42	5.3	7,893	7	6.0
1998/1999	4	70	11.8	5,986	8	8.8
1999/2000	4	119	9.8	12,038	11	10.8
2000/2001	6	213	13.7	15,568	9	26.6
2001/2002	8	376	15.0	25,017	10	37.6
2002/2003	9	221	8.4	26,363	17	13.0
Average (all)		119	7.5	12,988	8	13.6
Average (00/01-02/03)		270	12.3	22,316	12	25.7

* Total seasonal landing statistics provided by DFO-Statistic, Halifax.

Table 2. Preliminary report of weekly landing, catch rate, and effort statistics for Snow Crab in Area 4X for the 2002-03 season.

2002/2003			
Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)
Nov. 3	32,728	14.6	2,235
Nov. 10	31,097	13.1	2,375
Nov. 17	9,196	8.1	1,143
Nov. 24	9,378	18.0	520
Dec. 1	12,305	8.6	1,431
Dec. 8	5,924	5.7	1,041
Dec. 15	3,038	4.2	726
Dec. 22	1,141	8.5	135
Dec. 29	1,969	4.4	448
Jan. 5	7,060	5.8	1,209
Jan. 12	4,356	6.5	675
Jan. 19	123	2.1	60
Jan. 26	50582	5.3	1,047
Feb. 2	3,106	8.9	348
Feb. 9	3,747	4.2	885
Feb. 16	6,310	8.3	761
Feb. 23	6,337	9.7	653
Mar. 2	5,321	9.5	558
Mar. 9	5,423	8.5	640
Mar. 16	11,799	7.0	1,696
Mar. 23	6,522	5.0	1,306
Mar. 30	4,472	7.4	607
Apr. 6	6,618	5.6	1,182
Apr. 13	5,178	6.4	814
Apr. 20	6,839	5.1	1,335
Apr. 27	3,683	6.8	539
May 4	5,797	10.5	550
May 11	5,431	9.1	596
May 18	5,967	12.6	475
May 25	4,851	9.7	502
Average		8.4	
Total	221,298		26,363

Table 3. Catch composition, in percentage and number, from at-sea samples in Area 4X for 2002-03.

a) Catch composition in percentage (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
Trip	Trap		Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	
4	69	< 95 mm	1.6	35.1	0.1	0.3	1.8	35.4	37.2
		> 95 mm	8.7	53.7	0.1	0.3	8.9	54.0	62.8
		total	10.4	88.8	0.3	0.5	10.7	89.3	100.0

b) Catch composition in number (#).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
Trip	Trap		Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	
4	69	< 95 mm	12	257	1	2	13	259	272
		> 95 mm	64	393	1	2	65	395	460
		total	76	650	2	4	78	654	732

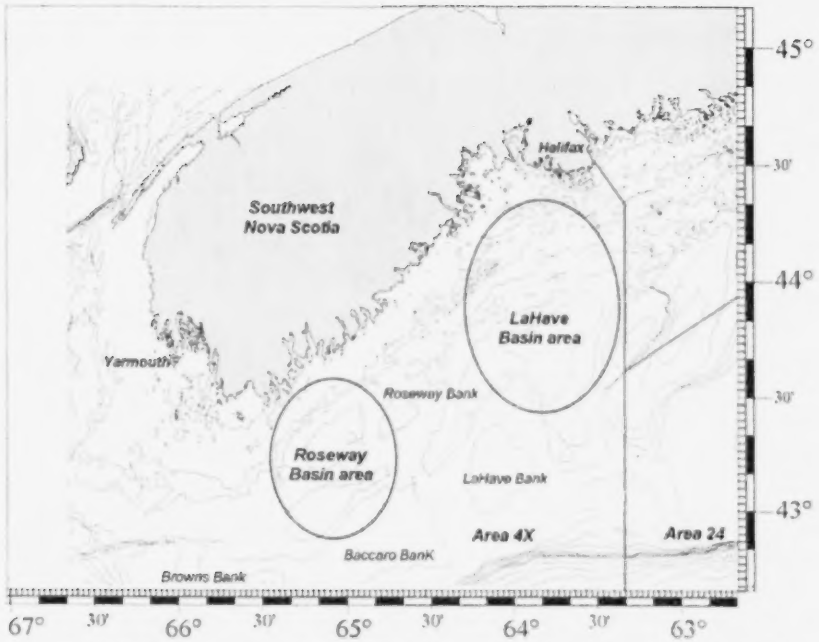

Figure 1. Snow crab fishing Area 4X (NAFO 4X) off southwestern Nova Scotia.

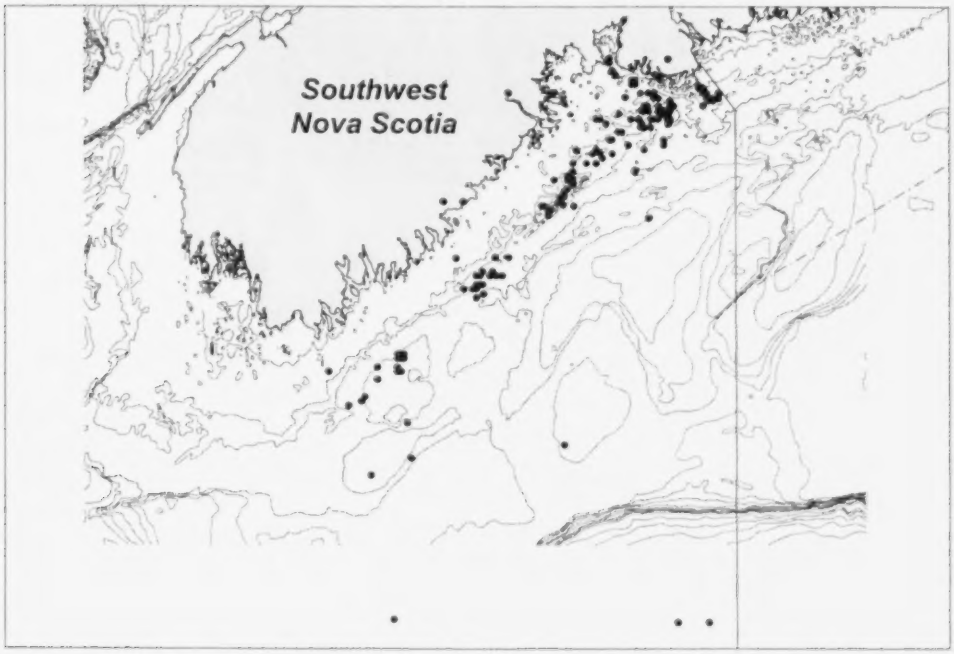

Figure 2. Reported logbook positions in 2002-03.

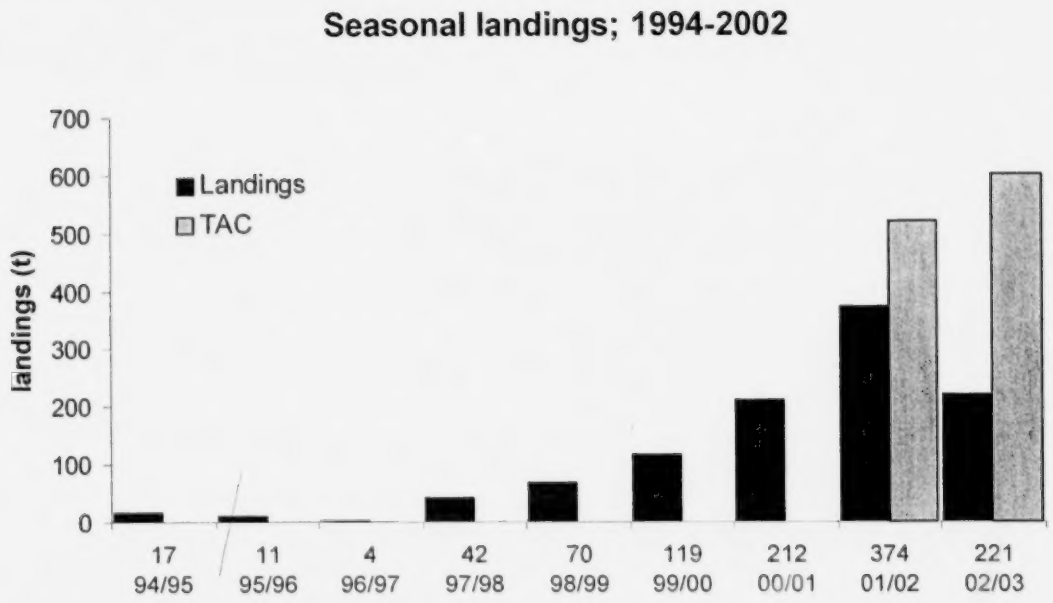

Figure 3. Seasonal snow crab landings (t) in southwestern Nova Scotia from 1994 to 2003.

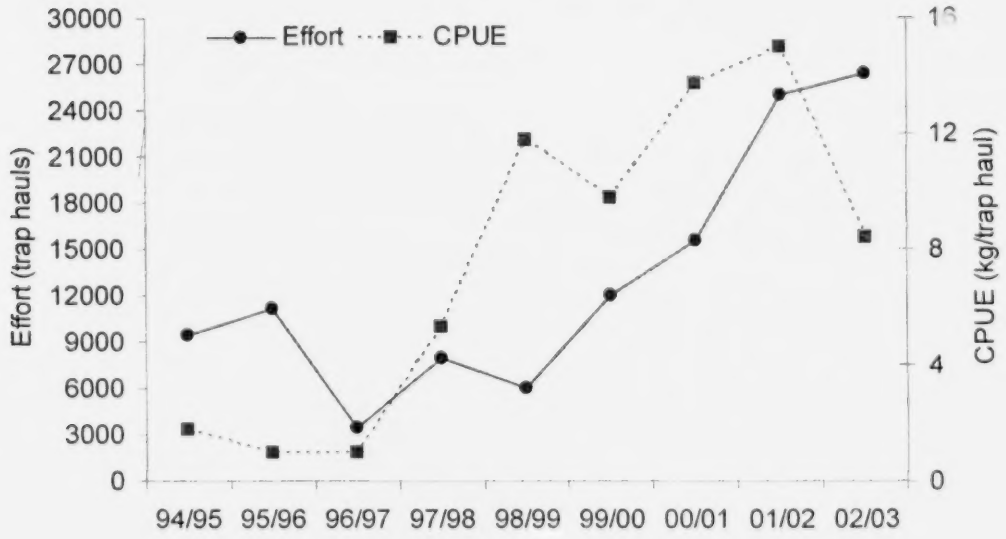

Figure 4. Fishing effort and Catch-per-unit- effort (CPUE) for snow crab in Area 4X from 1994 to 2003.

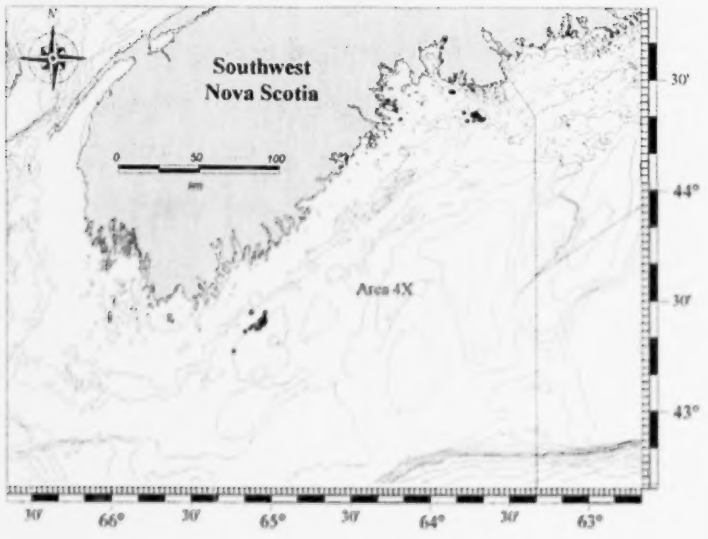

Figure 5. At-sea observer positions for Area 4X.

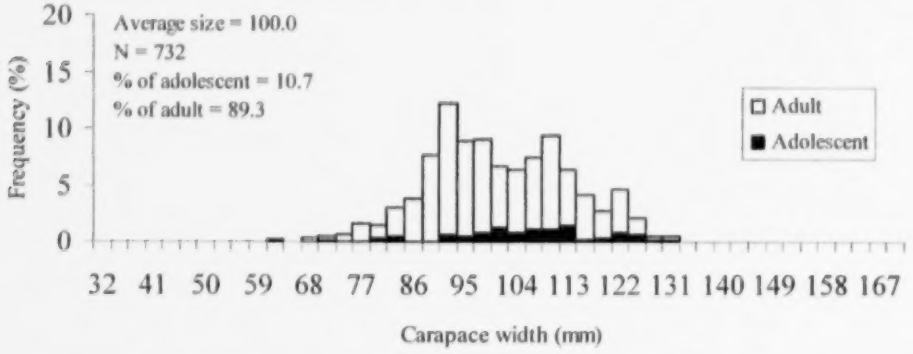

Figure 6. Snow crab size frequency distribution from the at-sea sampling in 2003.

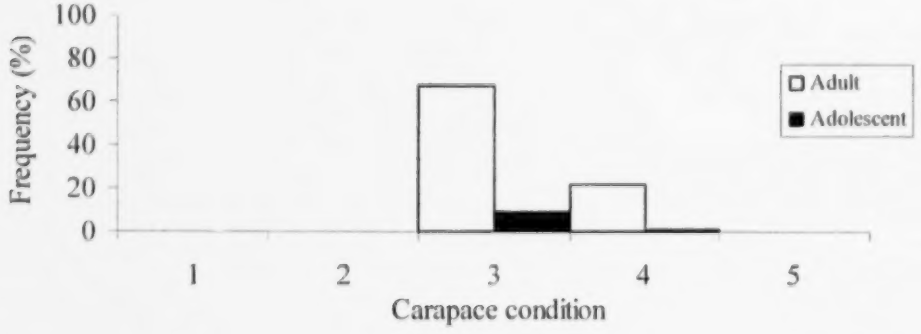

Figure 7. Shell conditions of snow crab captured in the at-sea sampling (traps) in 2003 carried out in southwestern Nova Scotia.

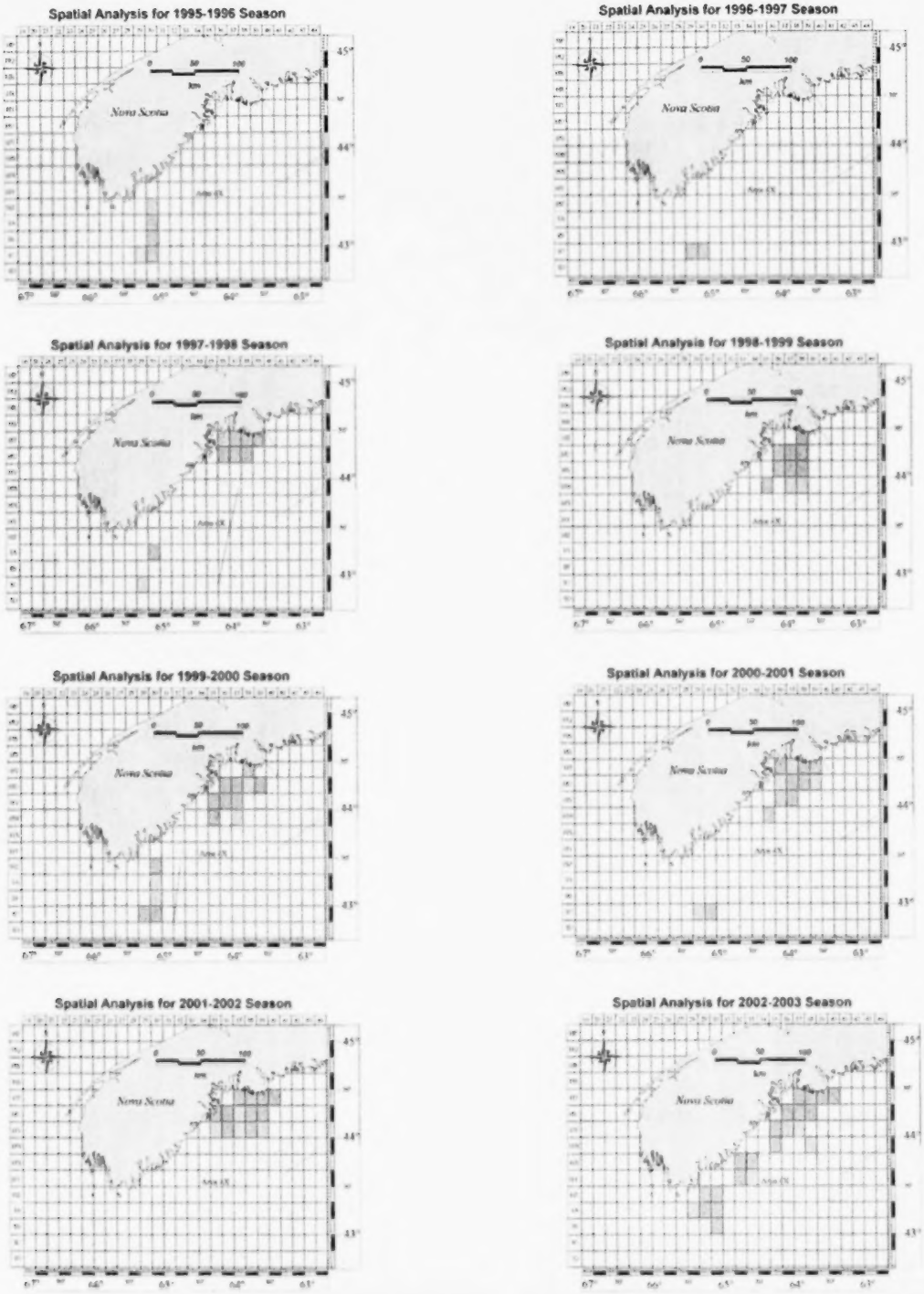
Spatial Analysis for 1995-1996 Season
Spatial Analysis for 1996-1997 Season
Spatial Analysis for 1997-1998 Season
Spatial Analysis for 1998-1999 Season
Spatial Analysis for 1999-2000 Season
Spatial Analysis for 2000-2001 Season
Spatial Analysis for 2001-2002 Season
Spatial Analysis for 2002-2003 Season
Nova Scotia

Figure 8. Spatial analysis of the landings of the 1995-2003 fisheries in Area 4X.
(yellow grids = grids necessary to account for 95% of the catch)

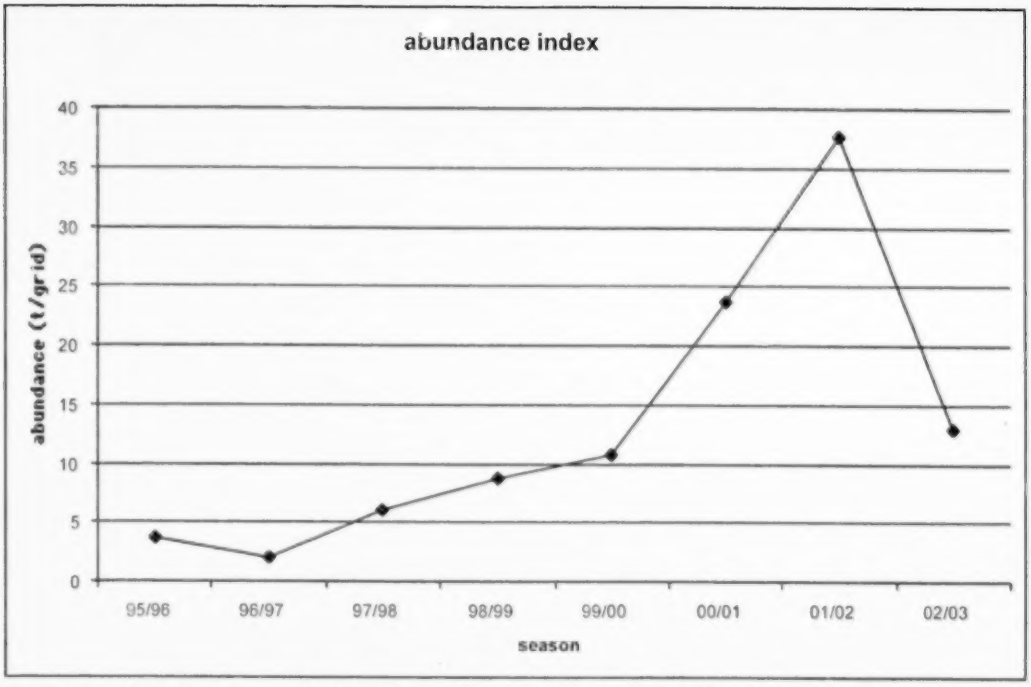

Figure 9. Index of snow crab abundance in Area 4X from 1995-96 to 2002-03.

Appendix 1

Classification of carapace stages based on carapace condition, durometer reading and corresponding approximate age after terminal molt (Moriyasu et al. 1998).

Category	Stage	Durometer reading	Carapace condition	Approximate age after terminal molt
New soft	I	< 68	brightly coloured, iridescent, soft, no epibionts, chelae easily bent.	0-5 months
Clean	II	variable	brightly coloured, some iridescence, may have epibionts, chelae not easily bent	5 months- 1 year
Inter-mediate	III	> 68	dull brown dorsally and yellow-brown ventrally, no iridescence, shell abrasion evident, epibionts.	8 months -3 years
Old	IV	> 68	carapace very dirty but hard, decay may be present at leg joints, epibionts removable at processing plant.	2 - 5 years
Very old	V	variable	carapace very dirty and may be soft (durometer reading < 68), progression of decay may be evident, epibionts not removable at processing plant.	4-6 years